Interim Progress Report submitted to
NOAA's Human Dimensions of Global Change Research (HDGCR) Program

Project Title: Climate, Water Scarcity and Management in Brazil and Chile

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A. Abstract

This comparative study examines the use of seasonal climate forecasting in water management in Brazil and Chile, two countries where a better understanding of climate variability may be critical to mitigating the effects of water scarcity. Both countries have initiated broad water reform programs which promote decentralized water resource management, and in the Brazilian case, integrated and environmentally sustainable management. Legislation in both countries stipulates that water is an economic good for whose use users should pay. Under these circumstances, the use of seasonal climate information can play a critical role in water management by allowing for pro-active planning and decisionmaking. However, technical and scientific (especially climate) information enters into watershed-level decision making in different ways, varying both with institutional design and pre-existing problem definitions. We must therefore disaggregate these, making it possible to identify and decipher characteristic patterns of combinations and their association with processes and outputs of water management institutions. Institutional patterns act as filters that determine how information is received and used. We have undertaken extensive institutional analysis of the water sector in both countries, focusing on the following research questions: What aspects of the structure, composition, procedural norms, or other aspects of institutional design and practice facilitate the incorporation of innovation (science-based information) in decision-making processes? How does the use of science-based knowledge affect decision-making within these institutions? How is such information presented, communicated, and how is it made operational? Does private ownership of water rights make actors more likely to seek out such information? Does use of scientific information support (through increasing transparency and accountability) or hinder (by promoting technocratic insulation) democratic decision-making processes? To answer these questions this project will compare the use of seasonal climate forecast across six watersheds, three in Brazil and three in Chile The study will combine quantitative analysis based on our surveys of decision-makers with qualitative methods (in-depth interviews with key informants and documentary research) to investigate the uses (actual or potential) of seasonal climate forecasting in decision-making at the watershed level.

In Brazil, we are collaborating with researchers involved in the Watermark Project, a multi-year study of factors affecting institutional innovation and consolidation of participatory watershed-level management institutions. The project has a commitment to share findings continuously with the groups and organizations being studied including watershed-based committees, government organizations, and the public. In Chile, we are building upon research already in progress within a NOAA funded project comparing the use of seasonal climate forecasting in agriculture and drought planning in the Limarí River basin in Region IV, one of the driest in the country as well as in two other watersheds located to the south of the capital city of

Santiago. All three watersheds in Chile share a common institutional framework, but show different levels of economic development, conflict, and use of techno-scientific information.

B. Objectives:

The goal of this study is to understand how policymakers and other users adopt and apply techno-scientific information, especially seasonal climate forecasting, in the management of water resources in Brazil and Chile. In order to accomplish that, we are carrying out extensive institutional analyses of the Brazilian and Chilean water management systems. We target both policymakers and direct resource users to build a broad database on the perceptions and use of climate information. We will develop a model for institutional analysis at the level of watershed decision-making through the analysis of six sets of variables:

- social political setting (federalism, political culture, level of decentralization)
- nature of the problem (physical characteristics, complexity, level of permanent structures, conflict/crisis)
- Individual values (paradigms, ideas, personal values)
- institutional complexity (Laws, norms, rules, overlapping jurisdictions, accountability, authority)
- organization culture (flexibility, accountability, capacity, resources)
- knowledge 'fit' (relevance, credibility, legitimacy)

C. Approach:

We focus on three watersheds in each country, taking into consideration the following factors:

a. In each country, we selected watersheds located in regions with comparable geoclimatic characteristics and under similar climatic fluctuations, that is, drought in Northern Chile and Northeast Brazil and flooding in the South. These watersheds are good representatives of the kind climatic stress and ecological conditions existing in a few regions of both countries;
b. Brazilian policymakers in the study area are actively implementing policies to move water management, towards a more decentralized, integrated, participatory and environmentally sustainable watershed-based water management system. Chile has had a decentralized water system since the 1980's, but some policy makers are attempting to modify the Water Code in order to promote a more ecologically conscientious use of water.
c. In all cases, agriculture and industry (including electricity) are the activities most vulnerable to climate variability;
d. The study regions are prone to drought and flooding associated with seasonal climate phenomena, such as El Niño/La Niña;
e. In both countries, conflict over water use by multiple users has become one of the most pressing issues on the governmental agenda.

We are proceeding inductively, testing loosely defined hypotheses in different socio-economic and institutional contexts. We use a multi-method approach that combines quantitative and qualitative research methods such as surveys, semi-structured, in-depth interviews, secondary analysis of national data, and personal observation, and interpretation of findings in relation to their wider social contexts. We recognize that the two levels of comparison (among different basins in each country and cross-national between Chile and Brazil) adds more complexity to the research. However, although we expect some variability from one national sample to the other, we trust that the richness provided by the ethnography of each of the basins selected for this study will outweigh whatever clarity we lose in general empirical propositions. On the other hand, by focusing on three basins in each country, we seek to maximize comparability by avoiding too different institutional settings (although this is less the case in "federalized" Brazil than in more centralized Chile). Similarly, because of the limitations inherent to research where small number of cases is studied, we focus on "comparable cases" that is, "similar in a large number of

important characteristics (variables) which one wants to treat as constant, but dissimilar as far as those variables are concerned which one wants to relate to each other" (Lijhart, 1971:687).

In this study, we propose to employ a combination of qualitative and quantitative methods and techniques to examine the following research questions:

- ♣ What aspects of a region's developmental trajectory and institutional history make users and/or policymakers more likely to seek out technical information on their own to bolster their positions?
- ♣ What aspects of the structure, composition, procedural norms, or other factors in institutional design and practice, make institutions more able to incorporate innovation (science-based information) in decision-making processes?
- ♣ How does the use of science-based knowledge affect decision-making within these institutions?
- ♣ How is such information presented, communicated, and how is it made operational?
- ♣ Does private ownership of water rights make actors more likely to seek out such information? Does use of scientific information support (through increasing transparency and accountability) or hinder (by promoting technocratic insulation) democratic decision-making processes?

The field team is carrying out in-depth interviews with policy and decision-makers at the watershed, state, and federal level where relevant for each of the case studies selected. Key informants have been identified through purposeful, opportunistic sampling where individuals "snowball," or refer, to other individuals, and the original list of persons consulted grows according to recommendations of the interviewees themselves. In this case, snowball selection is appropriate because, rather than formal hypothesis testing, the main goal of such interviews is to gauge policymakers' perceptions of their constraints and opportunities for using climate information in decision-making. In addition, we plan to apply a user survey so as to cross check information and understand users' perception of how information affects their ability to participate in decision making.

The research will contribute to scholarship in Policy Sciences, Environmental Sciences, Social Studies of Science, and environmental studies within the social sciences more generally.

Our focus on information flows and the interplay of technical and practical knowledge in institutional development, long a research focus for Lemos, has significant importance for the study of science and society and for development studies. By paying a great deal of attention to the development of informal practices in organizations, as well as to information flows and decision-making within and among them, we hope to contribute to the literature on political learning to which Keck has made significant contributions. By examining of the complexity/simplicity both of the organizations that deal with hydropower generation—to which the Chilean law give precedence during crises, and which are present in two of the three Chilean basins—and of other organizations related to water management in Chile (e.g., irrigators associations, some few farmers who receive real-time climate information from the local university), we hope to contribute to increase our understanding of the final water consumers' satisfaction under free market conditions.

D. Matching Funds:

This study collaborates with the Watermark project in Brazil, coordinated by Keck. The Watermark Project was set up to take advantage of the more or less simultaneous organization of decentralized watershed management institutions in most Brazilian states. It has received funds from the McArthur foundation, Hewlett Foundation and the Brazilian Ministry for Science and Technology (through CT-Hidro). It aims to generate broadly comparative data, over time, about a set of questions of interest to both scholars and practitioners, and to provide a space for an ongoing exchange of views and information. In addition, this studies leverages funds with NSF through a grant awarded to Lemos.

II Interactions:

A. With policymakers: we have begun to interview water and reservoir managers and other policymakers (from the electrical sector, for example) in the watersheds selected. In addition, the Watermark Project involves constant interaction with those policymakers who participate in it, most of whom have been deeply involved with the water reform project in Brazil. At the end of Year Two we plan to consolidate the results of our study with other Watermark Project research, to generate written materials targeting policy audiences and other efforts to foster comparative studies. We also plan to present our research findings to different stakeholders during the Watermark and PMRH project meetings and workshops. The planned workshop in Chile considers the participation of public servants and politicians involved in water issues. Additionally, we will negotiate with local authorities in Brazil extra funding for organizing local workshops in each of the studied watersheds.

B. With the climate community: the study also includes interviewing climate forecasters located in Santiago de Chile and in a few of the watersheds selected in Brazil.

C. With other NOAA projects: the study builds on previous research funded by NOAA in which both Leon and Lemos have been involved. It is also collaborating with another on-going project (originating at IRI) to understand the use of seasonal climate forecasting in NE Brazil (Kenny Broad, PI).

III Accomplishments:

Although we planned to carry out a substantial portion of the field research for the first year last summer, delays in the project start date and transfer of funds to the University of Michigan and subsequently to the subcontracts at Johns Hopkins and Universidad de Chile made it impossible to start as planned (actually funds were made available only by October 2003 despite a project start date of May 2003). Thus from October to April/04 the main activities under this award were:

- Extensive literature review of related themes, especially decision science, theory of institutions and institutional change, and co-production of science and policy.
- Supervised and advised the design of two related Master's research projects. Two SNRE/University of Michigan Master students—Diana Seales and Lori Kumler—are carrying out research within the scope of the project by examining user participation and use of information in two of the watersheds proposed, namely, the Itajaí River, in the state of Santa Catarina and Paraiba do Sul in the states of Sao Paulo, Rio de Janeiro and Minas Gerais. Diana Seales is expected to conclude her thesis in the summer of 2004 and Lori Kumler is preparing to carry out her field research in June/July 2004 (though partially funded by the NOAA grant she has also leveraged other funds from the University of Michigan Rackham Discretionary funds).
- In collaboration with the Watermark Project, the Co-PIs designed, pre-tested and are currently revising the questionnaire for a survey of members of a national sample of watershed committees in Brazil (1,000 respondents in 20 watersheds including the ones selected for this study). The survey's purpose is to assess the conditions under which these forums adopt democratic practices and become effective water management organizations. It will test the significance of several different kinds of variables for explaining participation and the ability to reach agreement on goals, including individual characteristics and beliefs (socio-economic status, area of specialization and worldviews), organizational processes (such as the role of leadership and the use of technical information), external context (such as socio-economic conditions). It also collects data helping measure the level of democracy and effectiveness of the organizations, recognizing that these characteristics cannot be fully captured through survey analysis,

which must be complemented with qualitative work. Finally, the survey includes a small battery of questions intended for network analysis, rather than the multivariate treatment . The survey contains modules on socioeconomic characteristics, organization, participation, world views, cohesion, and use of information. The Information Use module was designed specifically to address questions pertinent to this study, including past use of seasonal climate forecasting, perception of potential future use, perception of its relevance, accessibility and skill, and perception of impacts of the use of technical information on issues of democracy, accountability and ability to make decisions.

- To ensure comparability, the Chilean research team is utilizing the original survey designed in Brazil. Due to the differences in the institutional setting and non-existence of the "basin" as a management unit, the survey was adapted to the local conditions.
- Leon supervised and advised the design of José Miguel Arriaza's project, a Natural Resources Engineer research project. This study is currently underway in the Maule River basin.
- In the Maule River basin key stakeholders were contacted in order to initiate the "snowballing" process. Likewise, the research team attended a technical meeting hosted by the University of Talca during late 2003, where fresh fruit growers who are current users of techno-climate information provided by that university were contacted.
- At the central level, the team has interviewed several of the central figures within the forecasting community.
- Keck is supervising the work of two Johns Hopkins doctoral students whose individual dissertation projects make them particularly apt collaborators in this study. Thus Anna Gruben spent three months in the state of Bahia, in northeastern Brazil, studying user and civil society participation in watershed committees in a semi-arid region; she also applied a questionnaire developed by Lemos to technical personnel in two different committees (one fairly recent, and the other in process of being organized) in that state. She will now go on to repeat the process in two other states. Anna was recently awarded a Fullbright Hays fellowship for her dissertation research. Ricardo Gutiérrez will begin fieldwork in May for his dissertation study of how technical personnel working in state agencies organized themselves to influence water resource policy over the last few decades. He will include the same set of questions in his interviews in the south of Brazil (Rio Grande do Sul, Santa Catarina, Paraná). These studies will complement and strengthen (or point to flaws in) the more detailed analysis of our three study basins.
- As was foreseen in the work plan, Keck and Lemos were heavily involved in design of the Watermark Project's national survey questionnaire. In addition, besides collaborating in the general design and multivariate analysis, Keck will be primarily responsible for the network component. To that end, she has worked on her quantitative network analysis skills with specialists at the Johns Hopkins School of Public Health and at Rutgers University. For our purposes here, the network analysis will be particularly useful in identifying and assessing both the robustness and the reach of the pathways along which technical information is likely to flow.
- Keck and Lemos will spend a considerable part of the summer 2004 in Brazil, carrying out fieldwork relevant for this study.

IV. Relevance to the field of human-environment interactions

A.

- We expect the research on decision-making to generate both a data-base of decisions and an analytical report that, by means of the comparison between two countries, highlights both the strength and weaknesses of the current institutional framework and dominant organizational culture;
- We expect to build a theoretical model of seasonal climate information use among water mangers and other users which can inform data producers not only of the needs but also of the best strategies to communicate and 'package' climate forecasts for improved use.
- We expect to contribute, by raising the awareness of the climate change dimension, to the better integration of climate information into the decision making process in both countries. Likewise, we expect to inform a wide array of stakeholders on the existence and potential of seasonal climate forecasts. Thus, in moving towards decentralization and

integrated watershed management, both countries will perform better with more informed and educated stakeholders.

- We will improve collaboration between social scientists and different groups of stakeholders like e.g., decision-makers, water managers, engineers, farmers.
- Finally, the project will produce a research report that considers current forms of dissemination of drought and flood related information and their relevance (or lack thereof) for use of climactic forecasting information in policymaking and management of water resources.

B. This research builds on two previously NOAA funded projects about the use of seasonal climate information in Brazil (PI Maria Carmen Lemos) and a study comparing Brazil and Chile (PI Tim Finan). It also builds upon research on the use of seasonal climate forecasting by water managers in the United States (PI Steve Rayner) as well as on the CLIMAS regional assessment (RISA/OGP) (PI Jonathan Overpeck).

C. By building knowledge on the use of climate forecasts by a specific group of decisionmakers (water managers), this research will contribute:

a. To understand how such actors use information or perceive potential use of this kind of information in the future. Detailed knowledge of data use, in turn, will improve understanding of adaptive capacity of different water-related systems (reservoir management, electricity, irrigation, etc) both to climate as well as to other stressors such as increased demand, multi-uses, etc.

b. To better understand current institutional arrangements as a means to assess their 'fit', adaptability and effectiveness to plan and respond to global change. The study's focus on institutional analysis in a comparative perspective (both within countries and across countries) will significantly improve our understanding of the role of institutions (both formal and informal) and institutional adaptation in water management. This knowledge in turn, can critically inform the design and development of decisionmaking tools. Only by understanding how decisionmakers make decisions can we develop 'usable' tools.

c. To assess the role of climate information in policymaking and what can be done to expand and strengthen its influence in proactive governmental planning.